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A CHEMICAL STUDY OF ENZYME ACTION[1]

IN making up the list of papers to be presented at this meeting to-day, it was stated that the intention was to "get at the fundamental things in enzyme activity." Since the chemical nature of an enzyme is as fundamental for the understanding of an enzyme action as any other factor, I shall present some results obtained during the last six years bearing on this question.[2] It will not be necessary to give a definition of enzymes here or to present a classification of enzyme actions. This has been done repeatedly and it would appear that at present nothing essential can be added in this respect. The question will be taken up as a chemical problem. Certain definite chemical changes may be accelerated under definite conditions; certain products obtained from living organisms have the property of accelerating these changes; these accelerations can be controlled within limits by altering the conditions. The problem in its simplest terms is the study of the chemical nature of these products of animal or plant origin which accelerate the changes. At the same time, influences physical in nature, such as the solvent and the colloidal properties of the materials must not be lost sight of, as they undoubtedly play a part in modifying the velocities of the reactions.

[1] Presented at the meeting on "Enzymes and their Behavior" before the Division of Biological Chemistry, American Chemical Society, Boston, September 12, 1917.

[2] The work was published in a series of papers in *J. Am. Chem. Soc.*, 1912–15, and in *Proc. Nat. Acad. Sci.*, 1, 136 (1915), 2, 557 (1916); *J. Biol. Chem.*, 31, 97 (1917).

Since enzymes manifest their actions by increasing the velocities of chemical reactions, a large amount of work has been done in studying the kinetics of such reactions. The actual results obtained from such studies in so far as light has been thrown on the chemical nature of enzymes has been disappointingly meager. In fact the results which might be expected from such studies have been in large measure unsatisfactory. This may be shown by a brief survey of some of the work on the kinetics of invertase action, to which, from this point of view, more attention has been paid than to any other enzyme action. Invertase, as is well known, hydrolyzes cane sugar to form glucose and levulose. O'Sullivan and Tompson[3] in 1890, as a result of the study of the kinetics of this reaction, concluded that the reaction was of the first order, the velocity being proportional to the concentration of the cane sugar. Duclaux[4] in 1898, Brown[5] and also Henri[6] in 1902, found that the velocity of this reaction was not of the first order as shown by the lack of constancy of the velocity coefficients. Henri[7] suggested in 1905 that because of the colloidal nature of enzymes, the reaction belongs to a two-phase system to which the simple mass law is not applicable in the given manner. Hudson[8] in 1908 as a result of some new work in which the mutarotation of the invert sugar was taken into account, found that the hydrolysis of cane sugar in the presence of invertase gave velocity coefficients that were constant when calculated by the unimolecular formula. He therefore claimed to have confirmed the conclusions of O'Sullivan and Tompson. Michaelis and Menton[9] in 1913 disagreed with Hudson in attempting to express the velocity of the reaction as a simple logarithmic function of the sugar concentration and elaborated the view of Henri of the two-phase system and formation of an intermediate compound. Bayliss[10] in 1911 developed the view of such intermediate compounds as adsorption compounds and concluded that the rate of enzyme action was a function of the amount of adsorption compound in existence at any particular time. Nelson and Griffin[11] in 1916 developed the two-phase system view of invertase action and in 1917, as a result of an extended series of experiments, Nelson and Vosburgh[12] summarized and stated clearly the present status of the problem of the kinetics of invertase action. Their conclusions may be stated briefly as follows:

I. The velocity of inversion is directly proportional to the concentration of the invertase.

II. The velocity is nearly independent of the concentration of the cane sugar in the more concentrated sugar solutions, while in very dilute sugar solutions the velocity increases with increase in concentration of the substrate and finally reaches a maximum.

III. The results obtained agree with the heterogeneous reaction view and contradict the claim that the kinetics of invertase action conform to the unimolecular law for homogeneous reactions.

[3] O'Sullivan and Tompson, *J. Chem. Soc.*, 57, 834 (1890).

[4] Duclaux, *Ann. Inst. Pasteur*, 12, 96 (1898).

[5] Brown, *J. Chem. Soc.*, 81, 375 (1902).

[6] Henri, *Z. Physik. Chem.*, 39, 215 (1902).

[7] Henri, *Z. Physik. Chem.*, 51, 19 (1905).

[8] Hudson, *J. Am. Chem. Soc.*, 30, 1160, 1564 (1908).

[9] Michaelis and Menton, *Biochem. Z.*, 49, 333 (1913).

[10] Bayliss, *Proc. Roy. Soc. London* (*B*), 84, 90 (1911).

[11] Nelson and Griffin, *J. Am. Chem. Soc.*, 38, 1109 (1916).

[12] Nelson and Vosburgh, *J. Am. Chem. Soc.*, 39, 790 (1917).

IV. Adsorption is one of the controlling factors in the kinetics of invertase action, and the velocity of inversion curve has the same general shape as adsorption curves, as suggested by Henri.

This brief review will show the uncertainty of the conclusions from the results obtained in the study of the kinetics of one of the most carefully measured of enzyme actions. The factors controlling the velocity of this reaction are just beginning to be cleared up, the simple earlier views being incomplete.

An unsuccessful attempt to formulate the kinetics of enzyme action in a comparatively simple way may be mentioned. The hydrolysis of urea to form ammonia and carbon dioxide was used by D. D. van Slyke[13] to develop a general theory of the kinetics of such enzyme actions based upon the assumption of an intermediate compound between enzyme and substrate. Unfortunately, in the development of the equations a further assumption was introduced which limits their validity and applicability to definite conditions which are realized only in special cases.[14]

The study of the kinetics of enzyme action has not, therefore, led to any results with regard to the chemical nature of enzymes, even in the simplest cases of chemical changes. Practically all enzymes are colloids, and when the substrate also is a colloid, as in the action of a protease on a protein, it is obvious that the conditions are complicated to such an extent that a quantitative study of the kinetics of such a reaction appears to be almost hopeless, although valuable qualitative results may be obtained.

The study of the chemical nature of enzymes is complicated in most cases by reason of the complexity of the substances whose changes they accelerate. This difficulty can be obviated for a few of the enzymes. For example, the lipases and esterases accelerate the hydrolysis of fats and esters. While the mechanism of the hydrolysis of an ester to form acid and alcohol in the absence of lipase is not known definitely, still the compositions and properties of the initial and final products undergoing the enzymatic change are known. This eliminates, partly at any rate, one of the unknown factors of the enzyme problem, and is the main reason for studying lipase in connection with the question of the chemical nature of the active catalyst, the enzyme.

Practically all enzymes are colloids or are intimately associated with substances having colloidal properties. Furthermore, in a large number of cases, it seems that the enzyme is associated with protein matter, either as an essential part of the protein molecule, or accompanying it in such a way that separation has not yet been effected. Among the enzymes which chemically show the characteristics of proteins may be mentioned the amylase obtained by Sherman,[15] proteases and lipases. On the other hand, the invertase described by Nelson[16] is a carbohydrate phosphoric acid complex containing about one per cent. of nitrogen in the form of protein.

These facts make it evident that for the case of lipase, to use a specific example, the isolation of the enzyme in a pure state is a phase or part of the problem of the isolation of a pure protein, since in the separation of the active lipase from inactive material present with it, the resulting bodies approach more and more nearly in proper-

[13] D. D. Van Slyke and G. E. Cullen, *J. Biol. Chem.*, 19, 146 (1914).

[14] *J. Biol. Chem.*, 28, 389 (1917) .

[15] Sherman and coworkers, *J. Am. Chem. Soc.*, 1912–1917.

[16] Nelson and Born, *J. Am. Chem. Soc.*, 36, 393 (1914).

ties and composition those which are generally taken to typify proteins. In the problem of isolating pure proteins, it has been possible by careful treatment to obtain bodies having the same properties at different times. This is somewhat different from obtaining a pure protein possessing the same properties as when present in living matter. The operations involved in such isolations are always sufficient to change the properties of the protein to some extent. The problem of isolating a pure lipase, for example, must wait therefore for the solution of the problem of the isolation of proteins possessing the properties which they exhibit in living matter, using the term living to include also matter showing the actions of enzymes.

If, therefore, there is little hope at present of isolating a pure enzyme, considering also the colloidal nature of the material with which it is necessary to work, there is a possibility of attacking the problem in a somewhat different way. An enzyme, as a rule, accelerates a more or less specific reaction or group of reactions. Considering the very complex nature of the protein or other molecule which includes the enzyme, or with which the enzyme may be associated, and the more or less specific reaction which it accelerates, it would appear as if some definite grouping in the complex enzyme molecule were responsible for a given enzyme action. Although this is an assumption there is considerable ground for making it, considering the views held at present with regard to the probable mechanism of the reaction of ester hydrolysis, and the complex nature of the protein enzyme molecule compared with the comparatively simple ester, acid, alcohol molecules involved in the catalyzed reaction. At any rate, this is the view upon which the work on the chemical nature of enzymes was based; namely, that part of the complex molecular grouping of the protein material is responsible for a given action. The problem therefore resolves itself into a study of the chemical nature of this grouping.

The colloidal properties of the protein and other molecules as a whole also influence the rates of reaction, especially with insoluble fats in the case of lipase, for example. Emulsifying agents also play a part, but it appears from the experimental evidence available that such agents do not cause enzyme action in the absence of a definite enzyme grouping, while, on the other hand, enzyme action occurs even without the emulsifying or other agent, though perhaps not to as great extent as in their presence.

The main factor, therefore, may be taken to be the chemical grouping, the physical and other properties modifying to a greater or less extent the typical action of the active enzyme grouping though not changing its nature.

The point of view has been presented from which the study of the chemical nature of enzymes was developed. As stated before, the experimental work was done for the most part with lipase because of the better known properties of the substrate and its reaction products. The greater part of the lipase work was carried out with preparations from castor beans, although other sources were also used. There has been a general tendency in the study of enzyme actions to attempt to attain conditions under which the enzyme would show a maximum action. This method of studying the problem is likely to introduce a number of new complicating factors, so that it was considered that if the action was due to some definite grouping, a study of the factors which caused a loss of the action

might aid in throwing light on the nature of the grouping. A systematic study of the factors which caused inactivation of the esterase and lipase was therefore undertaken. The results were presented in detail elsewhere.

Inactivation of the lipase and esterase preparations was brought about by acids, bases, neutral salts, alcohols, acetone, esters and heat.

The different ways in which these preparations may be inactivated make it appear at first sight as if different reactions occur in the inactivations. If, however, a definite chemical group is responsible for a definite enzyme action, it might perhaps be more reasonable to assume that inactivation follows a definite reaction. The preparations used were essentially protein in character. There was no evidence that a dehydration, or loss of the elements of water, caused inactivation. Some of the reactions indicated that a possible hydrolysis might be a cause of inactivation. With proteins, hydrolysis is generally taken to occur with the —CO—NH— group, the peptide linking, which goes over into the carboxyl and amino groups. Experiments with all the inactivations in no case showed an increase in the formol titration such as would be expected in this reaction, and, therefore, makes the assumption of such a hydrolysis improbable. Coagulation of the material accompanied some of the inactivations. This physical change alone does not appear satisfactory as an explanation; some change in chemical structure unquestionably must accompany or produce the physical phenomenon. Furthermore, the lipase material in suspension in water showed the same activity as in 1.5 normal sodium chloride solution when tested immediately.

The explanations of the chemical changes accompanying inactivation so far suggested are not satisfactory. The reagents used are simple. It is difficult to conceive of a very deep-seated chemical reaction taking place under so many different conditions, none of a complex nature. The only chemical change which appears probable under these conditions is that involving a simple rearrangement within the molecule, such as a tautomeric change involving the change in position of a hydrogen atom. In considering the structure of proteins it is evident that such a rearrangement is possible in the peptide linking.

The hypothesis to be suggested is that the active grouping of the esterase and lipase preparations is of the enol-lactim structure, —C(OH)=N—, the specificities being dependent in part upon the groups combined with the carbon and nitrogen, and that inactivation consists primarily in a rearrangement to the keto-lactam group, —CO—NH—.

This hypothesis was tested in several different ways. It has been found that in tautomeric substances, the presence of alkali in solution favors the enol form of compounds showing such tautomerism, while acid favors the existence of the keto form. The hydrolytic actions of some simple dipeptides on esters at different hydrogen-ion concentrations would, therefore, be evidence bearing on this point, the alkaline solutions presumably favoring the enol-lactim structure. In order to find the actions exerted by the amino-carboxyl groups of the peptide, the hydrolytic actions of a number of amino acids on different esters were determined at the same hydrogen-ion concentrations. The actions of the dipeptides and amino acids were also measured with the amino-carboxyl groups actions masked by the hydrogen of the carboxyl group being replaced by the ethyl group,

and also by testing compounds such as hippuric acids, which do not contain an amino group.

In these compounds, it is possible that the equilibrium between the keto-lactam enol-lactim forms might be changed rapidly if the conditions were changed slightly. A more stable substance was therefore studied from this point of view. Imido-esters, as shown by the formula (*a*), possess the enol-lactim structure in which the hydrogen atoms may be substituted by organic radicals. The hydrolytic actions on esters of ethyl imidobenzoate (*b*) at different hydrogen-ion concentrations and various conditions were measured.

$$\underset{(a)}{R-C(OR')=NR''}, \qquad \underset{(b)}{C_6H_5-C(OC_2H_5)=NH}$$

Finally, in order to reproduce the conditions and properties of naturally occurring lipases as far as possible, a number of different proteins were treated with alkali for the purpose of producing an enol-lactim grouping in the peptide linking if this were possible, then neutralized to different hydrogen-ion concentrations and the hydrolytic actions tested on a number of different esters.

As the data obtained have been presented in detail in the papers referred to, they will not be repeated here. It may be stated that the assumption with regard to the active grouping has been borne out by the experimental facts with the different series of compounds. Especially interesting are the ester hydrolyzing substances obtained by the action of alkali on a number of proteins.[17]

It must be emphasized that no direct conclusive evidence is presented as to the actual chemical configuration of the active lipase grouping. The steps in the reasoning may be summarized as follows:

Inactivation (and therefore also activation) is assumed to be due to a tautomeric rearrangement whose possible nature is indicated. Simple substances possessing such structures show the actions and some other properties of naturally occurring lipases present in protein materials. Inactive proteins treated in such a way as to produce the supposedly active grouping show ester-hydrolyzing properties.

Whether it is possible to go much beyond this in the present state of the knowledge of the chemical nature of proteins and the changes they undergo with simple treatment, is an open question. However, one possible line of development bearing directly upon the present problem may be indicated.

The equilibrium in solution between the tautomeric forms of acetoacetic ester, and also of other substances, depends to a great extent upon the solvent.[18] This suggests that with the enol-lactim keto-lactam tautomerism in proteins, the colloidal properties of the protein material may well exert an influence on the grouping comparable to the effects of the solvent on the tautomerism of acetoacetic ester just mentioned. The decreased stabilities or increased rates of inactivation of enzyme preparations when separated to a greater or less extent from colloidal and other matter not connected with the actions may then parallel the actions of the solvents on the equilibria between the tautomeric forms of acetoacetic ester.

In the development of the hypothesis regarding the active grouping in lipase actions, the experimental work and discussion was limited almost entirely to the pep-

[17] F. H. Frankel, *J. Biol. Chem.*, December (1917).

[18] K. H. Meyer and F. G. Willson, *Ber.*, 47, 832 (1914).

tide linking. It is evident, however, that such tautomeric structures, enol-lactim and keto-lactam, may be present in other groupings, and the results of this investigation in no way limit the lipolytic activity to the peptide linking. In view of the complexity of the protein molecule, it is highly probable that such tautomeric groupings are present in combination with other groups and that the specificities of the actions are in part dependent upon these.

It must be admitted that the treatment of proteins with alkali to form active substances is rather drastic. Unquestionably, simpler methods, comparable to those taking place in nature, will be found to produce the same effects. The fact that dilute alkalis inactivated the castor bean globulin lipase, while a certain higher concentration of alkali produced an ester-hydrolyzing substance from the inactive globulin preparation, indicates that differently placed groups in the molecule were involved in these two changes.

In how far the conclusions reached with lipase may be applied to other enzymes is a question. It seems probable, because of the comparatively simple treatments by which most enzymes may be inactivated, that with them also a simple rearrangement or perhaps tautomeric change is connected with loss in activity. There is, however, no reason to suppose that the active grouping is the same for all enzymes. Each enzyme must be studied separately and conclusions as to the chemical nature of one active enzyme grouping can not without further evidence be applied to an enzyme grouping connected with a different action. The work described with lipase has given a definite point of view, if nothing further, from which the study of this enzyme may be continued, and it seems probable that similar systematic studies with other enzymes would yield interesting and valuable results.

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THE CONSERVATION OF WHEAT

THE U. S. Food Administrator has done, and is doing, a splendid work in the conservation of wheat, notwithstanding the many obstacles which he has had to overcome. He has met, with wonderful ability and success, one of the most difficult situations of the ages. At times he has been harassed by self-appointed experts and advisers who have often hindered when they should have helped in the conservation of food, particularly of wheat. This is a time to put aside hobbies and pet theories and look the facts squarely in the face.

One of the suggestions frequently offered to make the wheat crop go farther is to mill it so as to include with the flour a portion, or all, of the wheat by-product, and then to require universal use of such a flour. The present ruling of our Food Administrator, permitting the manufacture of whole-wheat flour and also of flour that contains approximately 75 per cent. of the wheat kernel, rests upon a sound, economic basis. The usual argument of the whole-wheat flour advocates is that the product is more nutritious, and that the wheat can be made to go farther when it is milled so as to include a part or all of the by-product.

The March 8 (1918) issue of SCIENCE contains an article: "Shall We Eat Whole Wheat Bread?" by L. A. Dutcher, in which reference is made to my work on the nutritive value of breads. This article follows the usual trend of the whole-wheat bread advocate. I would make no mention of the article if it were not for the fact that I believe attention should be called to certain omissions, a misquotation and a selective and unusual use of data from my publications that might lead to erroneous conclusions, particularly as one of the bulletins quoted, Minn. No. 54, is no longer in print, or available for distribution.

Dutcher says:

> Using Professor Snyder's own digestion coefficients, we find the energy available in patent, whole wheat and graham breads was 90.9, 89.8 and 85.1 respectively.

The reference figure refers to Bulletin 126, U. S. Department of Agriculture, O. E. S. While upwards of thirty individual digestion trials are reported in this bulletin arranged in groups of three tests for each flour, the above figures which Mr. Dutcher uses are not the averages of all the tests on each flour, but he has selected the group of figures which gives the highest energy values for the whole-wheat and graham flours and the lowest for the white. This fact will be observed from the following table compiled from the bulletin mentioned.

AVAILABILITY OF ENERGY OF BREADS

Bul. 126, U. S. Dept. Agr., O.E.S.

	White	Whole Wheat	Graham
From page 29, average of 3 .	90.9	89.8	85.1
From page 29, average of 3 (1899–1900)	90.1	85.5	80.7
From page 29, average of 6 .	90.5	87.6	82.9
" " 45, " " 3 .	90.4	84.2	82.6
" " 45, " " 3 .	94.2	88	

Dutcher uses the first line of figures (90.9, 89.8, 85.1).

In my work which he assails I have used the average of all results recorded in this and other bulletins of this series. Dutcher could have selected tests where the difference between the two flours was eight per cent. and more instead of about one per cent., had he so desired. (See Bull. 156, U. S. Dept. Agr., O. E. S. p. 56) It can not consistently be argued that this selective use of data does not affect the final conclusion which he draws:

> We can rest assured that the difference in digestibility of the two flours is not great.

No data are presented upon which to rest such an assurance.

He attempts to show that my early tests, in 1897, on the digestibility of whole-wheat bread are different from my later tests. He says, quoting from Bulletin No. 54, Minn. Experiment Station:

> Omitting details of the separate experiments it was found that there was practically no difference in the total digestibility of breads made from the three kinds of flour (patent, bakers' and whole-wheat flours). This sentence is selected from the article "The Digestibility and Composition of Bread" as noted on the title page of bulletin No. 54.

The quotation is inaccurate. Mr. Dutcher adds the part put in parenthesis, but omits the final conclusion reached that says: (p. 44).

> As to the superior merit of whole-wheat flour over ordinary flour, it is more a question as to the quality of the wheat from which each flour has been made.

Omission is also made of the fact that in this test the whole-wheat flour was not milled from the same wheat as the white flour. It was purchased in the open market and "had evidently been made from winter wheat." p. 44. Had Dutcher followed the footnote on page 43 he would have found the patent flour was made from spring wheat, (See Bulletin 67, U. S. Dept. Agr., O. E. S. p. 34.)

It may be argued that his additions to the sentence simply tend to make my meaning clear, and that what he adds is correct. That is not the case. The sentence he quotes begins with: "Omitting details." He has added details. Any additions should have been complete and should have given the reader all the information necessary to understand the sentence when separated from the article. The sentence without Dutcher's additions, and separate from the rest of the text has no special meaning. Dutcher could have quoted a sentence that would have given all the facts, and which would have been complete when separated from the text, namely, the sentence given above summarizing the entire experiment, that the merit of one flour over the other "is more a question as to the quality of the wheat from which each flour has been made." Dutcher's additions to the sentence "(patent bakers' and whole-wheat flours)," without the necessary qualifications, mean products entirely different in character from those of the same name, in all other tests. It is like two

John Smiths, same name, but different persons and with distinguishing characteristics, which he has omitted.

This initial test in 1897 showed the necessity of having the whole-wheat and white flours milled from the same wheat, which was done and so reported in all subsequent work. The necessity of having all flours compared, milled from the same wheat is specifically mentioned in Director True's letter of transmittal[1] to the Secretary of Agriculture. He says:

> A special point in connection with Professor Snyder's report is that the different samples of flour used were all ground from the same lot of wheat. His investigations form an unusually satisfactory basis for judging the comparative nutritive value of so-called "graham" flour, which contains the whole-wheat grain and which is really an unbolted wheat meal; so-called "whole-wheat" or "entire-wheat flour" obtained by removing part of the bran and grinding the rest of the kernel; and ordinary patent flour.

In order to make it appear that as large amounts of nutrients are obtained from the whole-wheat as from the white flour, Mr. Dutcher selects the only case where the whole-wheat and white flours were made from different wheats and so indicated in the original, and, omitting to state this, applies this single result with the very large number of results where the two flours are milled alike from the same wheat. Such a method of comparison makes an unwarranted use of my data and is unscientific.

He also states:

> Professor Snyder has gone a step farther and makes the assertion that whole-wheat flour is not only less nutritious, but is actually harmful, causing diarrhea and digestive disturbances.

This is not correct. I have never made such a statement. I have repeatedly pointed out the physiological value of whole-wheat flours for correcting some cases of constipation, and also stated that when there is a tendency to diarrhea the whole-wheat bread may aggravate this disturbance, and suggested that the consumer must determine the fact. Certainly no one else can. This question can, however, be consistently raised as noted later.

In discussing scientific subjects it is unusual to suggest ulterior motives, as he has done; such a procedure is not in the domain of science.

Dutcher gives a summary of some statements in answer to a letter sent out by a "government chemist of prominence," name not given. Any prominent government chemist who at this time really has anything of value to offer would readily have his work accepted and published by the government, and it would not be necessary to get Dutcher to publish it for him. It would be interesting to know if he has presented his views and had them rejected by the government and the Food Administration.

No mention is made of others who have obtained similar results to mine, or to the fact that my work was repeated at the University of Maine by Woods and Merril and checked at Washington by the U. S. Department of Agriculture, under whose direction the tests were made. They extended over a period of ten years.

Mr. Dutcher makes a vigorous outcry against the price of bran, and advises methods of farming whereby the farmers "would never again resort to the expensive mill feeds." And this at a time when farmers are being urged to raise more wheat! The U. S. Food Administrator permits the miller to take a profit of 50 cents per ton on his bran. The above and others of his statements are made without sustaining facts.

But to return to the subject, "The Conservation of Wheat." It is argued that the wheat crop can be made to go further by using whole-wheat flour. We have an abundance of corn but a shortage of wheat. The question is then: How can we use jointly the two crops to the best advantage?

A pound of wheat by-product used as human food supplies about 500 available calories and about .05 of a pound of digestible protein. A pound of corn meal or corn flour supplies over

[1] O. E. S. Bulletin 101, U. S. Department of Agriculture.

three times as much available energy and 75 per cent. more protein.

The wheat by-product alone has no physical bread-making value; it is exactly on a par with corn meal or any other cereal product that has no gluten. Why, then, should we use wheat by-product in bread-making to conserve wheat, when corn meal, or corn flour or other cereal flours furnishes pound for pound so much more digestible protein and available energy?

The presence of the wheat by-products lowers the amount of other cereal that can be blended with flour. That is, you can not use as much corn, barley or oat flour in combination with whole-wheat flour in making bread as you can when using ordinary white flour. In the rationing of Belgium when whole-wheat flour (82 per cent.) was used, Mr. Robinson Smith, of the Commission for Relief in Belgium, in discussing corn, says:

> Its chief value as maize flour was in mixing with the wheat flour up to 11 per cent.

In our bread at the present time 25 per cent. and more corn or other cereal flour is used with white flour. The use of whole-wheat flour *reduces* the amount of other cereal that can be combined and made into bread, and also reduces the amount of available energy and digestible protein contained in the loaf.

Furthermore, wheat by-product is more completely digested by animals than by man, a pound of wheat feed in a mixed ration for animals is worth a little more than a pound of corn.

We have an abundance of corn and a shortage of wheat. Milk is a necessity as human food, also butter, eggs and meat, and these must be produced as cheaply as possible.

When man uses as a bread mixture 75 per cent. white flour and 25 per cent. corn meal or corn flour then all of the wheat by-product is available as animal food, where it is more valuable than when used as human food; while in turn the corn goes farther as human food than the by-product it replaces. This certainly is a valuable and an economical substitution of corn for wheat by-product as it benefits both the human and the animal.

If we should use whole-wheat flour only and 12 per cent. corn flour as a bread mixture, the wheat supply would not last as long as when white flour is used with 25 per cent. of corn flour.

In view of these facts it is not surprising that the U. S. Food Administrator followed the course he did in regard to regulating the milling of flour and the making of bread.

The long extraction flours of other countries are frequently mentioned as an example for the United States to follow. Surely we should profit by their example to the extent of avoiding their mistakes, but there is no reason why we should copy their mistakes and failures. France was the first country to lengthen the extraction of the wheat to 82 per cent. Recently she has gone back to the old standard. (Commerce Reports, U. S. Dept. Commerce, January 7, 1918, p. 79.) The change to long extraction was not a success. Professor Bertrand, chief of the service staff of the Pastuer Institute, has pointed out that in digestion of the long-extraction flours "there are other considerations that tend to reduce" the actual available calories, and that they have not been previously considered, namely: the loss of energy due to the "digestive work" of the "excess of inert substances" in the long-extraction flour. This factor has not been numerically determined but it would still further reduce the available nutrients of the whole wheat. The change of the French government from the long extraction of wheat as a war-time conservation measure back to normal basis is certainly significant. The experiment failed. We should profit by this failure.

The whole wheat and graham advocates usually place great stress upon their wholesomeness, richness in minerals and to certain unknown components to which the name "vitamine" has been applied. A restricted diet may have an insufficient amount of mineral matter or growth-promoting substances, improperly called "vitamines," as well as an insufficient amount or kind of protein, but in a diet with a variety and ample amount of food there is no danger whatever of any deficiency. The U. S. Public Health Service says:

It may be added that a great majority of the people of this country live on a well-balanced, sufficient, mixed diet.[2]

From a recent memorandum for the Secretary of War issued by George W. Goethals, Acting Quartermaster General of the U. S. Army, in reply to a plea for the exclusive use of whole-wheat and graham breads by our soldiers the following quotations are made:

It is recognized that particular care must be observed in the composition of bread. In order to prevent sickness among the civilian population of Italy caused by the use of whole-wheat flour, the Italian government was compelled to fix the percentage of whole wheat at 85 per cent. During the Boer War the British troops in South Africa experienced similar troubles from a like cause. This is due to the fact that the husks or outer covering of the wheat irritate the membranes of the stomach and cause increased intestinal secretions. "This is well known and our trained bakers have been taught to avoid the use of whole wheat flour when possible."

This report of Gen. Goethals is not to be considered lightly.

As to the "vitamine" deficiency of milled products, as white flour, Dr. E. V. McCollum, now of the Johns Hopkins University, in an address before the National Association of American Dairy Food and Drug officials, said:

It is time to warn against the widely heralded teaching that the several diseases recognized as of dietary origin, such as scurvy, beri-beri and possibly pellagra are necessarily due to the absence or to an inadequate supply of "vitamines." We should remember, however, the importance of the other factors of which I have spoken, and in considering the stand to be taken with respect to the milled products, keep in mind that the grains from which they are prepared are themselves singly and collectively as they come from the hand of Nature, incapable of supporting the health of an animal during growth. . . . In closing let me repeat that successful nutrition is not assured by the consumption of the foods just as they are supplied by Nature. It is to be attained only by the judicious combination of foods with a knowledge of their dietary components.

Recognizing this broader conception of nutrition and the necessity of a judicious combination of foods to effect perfect nutrition, then whole-wheat flour and white flour and the grain itself all stand on the same level, for if used either singly or collectively they fail to affect perfect nutrition.

We must conserve wheat. The best way is to use corn and other cereals. In using whole-wheat flour you are still using wheat. Whole-wheat flour has a place in the dietary. It can not, however, replace white flour. Over 90 per cent. of the ordinary whole-wheat flour is composed of white flour. The person who eats whole-wheat flour to conserve wheat only deceives himself. It is better to look the facts squarely in the face and use something else. The way to conserve is to conserve. Make absolutely wheatless meals or wheatless days. It is now necessary to do so. Let us do it cheerfully.

HARRY SNYDER

[2] P. H. Reports, Vol. 31, No. 33, p. 2205.

SCIENTIFIC EVENTS

THEODORE CALDWELL JANEWAY, BORN 1872, DIED 1917

AT a meeting of the board of scientific directors of The Rockefeller Institute for Medical Research, the following minute was adopted:

Resolved, that the scientific directors of The Rockefeller Institute record their profound sense of loss in the death of their honored and beloved associate, Theodore Caldwell Janeway, M.D., who has served on the board with devoted zeal since his election to succeed Dr. Christian A. Herter in 1911. Dr. Janeway at the height of his powers and in the midst of the most productive period of his life was stricken with pneumonia while in active service in the Medical Corps of the Army, to which, since the United States entered into war with Germany, he gave invaluable and unmeasured service. His life was sacrificed to patriotic duty rendered to his country without reserve. Dr. Janeway's period of office on the Board of Scientific Directors of The Rockefeller Institute was restricted to a brief seven years, yet its importance was very great, as he brought to its service learning, keen intelligence and broad vision.

Dr. Janeway was a highly skilled and widely read clinician, and he was also a notable exponent of the scientific method in internal

medicine. A graduate of the Sheffield Scientific School and of the College of Physicians and Surgeons, he emphasized the importance of chemistry and physics, the two sciences on which he based his clinical conceptions. Coming early under the mature and wise influence of his distinguished father, he received from him the more pure clinical and pathological impress which so much contributed to his broader development. In rapid succession Dr. Janeway became instructor in medicine at New York University and Bellevue Hospital Medical College in 1898, and Bard professor of medicine at Columbia University in 1909. During this period, in 1907, he was instrumental in founding the Russell Sage Institute of Pathology, which throughout its connection with the City Hospital was made a valuable adjunct to the courses in medicine which he conducted. It was natural and logical, because of the work he had done in internal medicine, that Dr. Janeway should be called to fill the full-time chair in internal medicine at the Johns Hopkins Medical School in 1914. The acceptance of the new professorship was made at a large financial sacrifice, but his altruistic action was wholly consonant with the broad and sympathetic attitude which he always held toward medical teaching and research.

Dr. Janeway's untimely death cut short not only a career in medicine which he had inaugurated with every promise of distinguished success, but has at the same time deprived The Rockefeller Institute of one of its ablest and wisest counsellors, and the medical profession of a great physician.

MEDICAL TERMINOLOGY

Dr. Franklin Martin, member of the advisory commission and chairman of the general medical board of the Council of National Defense, has issued the following statement:

In view of confusion arising because of different terms used in various medical groups to designate the same things it was deemed advisable that a conference be held to discuss the adoption of uniform nomenclature. Accordingly, an informal preliminary conference has been held at the office of the medical section of the Council of National Defense and it is believed that a promising start toward reaching the desired end has been taken.

In a small percentage of instances the same diseases are designated by different words. Similarly, injuries of identical nature, identical operations, procedures such as surgical dressings, diagnostic tests and methods of treatment are, in different branches and in different localities, given different names. The same symbol should be used to designate the same condition. There is also lack of uniformity in abbreviations used in various medical records, such as hospital histories, written orders and laboratory reports.

It is obvious to all medical men that, as a means of a quick understanding and saving of time in these days when time is so precious, the same nomenclature and abbreviations for all identical things should be used. The men who attended the conference were agreed as to the desirability of such entire uniformity.

A net result of the meeting, inasmuch as the Army, Navy and Public Health Service are practically in accord, was the passing of a motion that the Council of National Defense, medical section, should request the Surgeon General of the Army, the Surgeon General of the Navy, and the Surgeon General of the Public Health Service each to name a representative to confer on the matter of agreement concerning names of diseases and injuries. It was also voted that after such a list has been prepared there should be called together representatives of the leading national bodies who should have a voice in such decisions. Once a general agreement is reached the 20,000 doctors who go back to civil life after the war will automatically bring these lists into general use throughout the hospitals of the country.

Those who attended the conference were Colonel Albert G. Love (for sick and wounded records), Colonel Champe C. McColloch, Jr. (for the history of the war), both as representatives of the Army; Assistant Surgeon Charles E. Alexander, statistician for the Bureau of Medicine and Surgery, representing the Navy; Dr. B. S. Warren, statistician for the Public Health Service; Dr. W. H. Davis, of the vital statistics section of the Census Bureau; Dr. W. T. Longcope, as one who could speak for medical colleges; Dr. John W. Trask, who, as a member of the American Medical Association's Committee on nomenclature, could speak for organized medicine, and Dr. Robert L. Dickinson, of the medical section of the Council of National Defense.

LECTURES ON PUBLIC HEALTH

Surgeon-General Gorgas has arranged for a series of "Half-hour Health Talks" for the

civilian employees of the War Department, to be held Tuesday and Thursday afternoons at 4.45 o'clock, in the auditorium of the Department of the Interior building. All civilian employees of the War Department are cordially invited to attend. The following is a partial list of the lecturers and their subjects:

Thursday, April 25. "Cancer, its prevention," by Major William J. Mayo, Medical Reserve Corps, United States Army, Surgeon General's Office, Rochester, Minn.

Tuesday, April 30. "Part to be taken by women in modern sanitation," by Lieutenant Colonel W. H. Welch, Medical Corps, National Army, Johns Hopkins University.

Thursday, May 2. "Practical information for the care of the eye," by Major G. E. De Schweinitz, Medical Reserve Corps, University of Pennsylvania.

Tuesday, May 7. "Care of the foot and its proper covering," by Lieutenant Colonel E. G. Brackett, Medical Corps, National Army, Harvard University.

Thursday, May 9. "The activities of women during the present war," by Miss Annie Goodrich, Surgeon General's Office, Teachers' College, Columbia University.

Tuesday, May 14. "Focal infection in relation to general diseases," by Lieutenant Colonel Frank Billings, Medical Corps, National Army, Chicago University.

Thursday, May 16. "Food, dietetics and nutrition," by Major John R. Murlin, Sanitary Corps, National Army, Cornell University.

Tuesday, May 21. "Posture in its relation to human efficiency," by Miss M. Sanderson, department of physical reconstruction (superintendent, Boston School of Physical Education).

Thursday, May 23. "Typhoid fever and its prevention," by Colonel F. F. Russell, Medical Corps, Laboratory Division, Surgeon General's Office.

Tuesday, May 28. "Our hospital facilities and requirements," by Lieutenant Colonel W. H. Smith, Medical Corps, National Army, Surgeon General's Office, Johns Hopkins University.

Thursday, May 30. "Hygiene of the mouth," by Major Leonard G. Mitchell, Medical Reserve Corps, Surgeon General's Office.

Tuesday, June 4. "Social hygiene," by Kate B. Karpeles, Surgeon General's Office, Acting Assistant Surgeon, United States Army. (This lecture for women only.)

Thursday, June 6. "Care of the skin" (clothing, bathing, exercise), by Dr. William A. Pusey, Surgeon General's Office.

RESEARCH GRANTS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE committee on grants of the American Association for the Advancement of Science, by a practically unanimous vote, recommends the following appropriations:

$300, to Mr. William Tyler Olcott, secretary, American Association of Variable Star Observers, 62 Church Street, Norwich, Connecticut, for the purchase of a telescope of 5-inch aperture.

$250, to Professor A. E. Douglass, of the University of Arizona, Tucson, Arizona, for the length of record of tree growth of the Sequoias from about 2,200 to 3,000 years.

$500, to Professor Carl H. Eigenmann, of Indiana University, Bloomington, Indiana, for the study of the fresh-water fishes of South America.

$500, to Professor Edwin B. Frost, of Yerkes Observatory, Williams Bay, Wisconsin, for measurement and reduction of photographs of stellar spectra, already taken with the 40-inch telescope.

$200, to Dr. R. A. Porter, of the University of Syracuse, Syracuse, New York, for explanation of the hysteresis which has been observed in the potential gradients of the calcium-cathode vacuum tube.

$200, to Professor E. W. Sinnott, of The Connecticut Agricultural College, Storrs, Connecticut, for experiments to determine the ratio (in dry weight) between root, stem, leaf and fruit in the bean plant.

$500, to Professor O. F. Stafford, of the University of Oregon, Eugene, Oregon, for research on the distillation of wood.

$200, to Professor Herman L. Fairchild, University of Rochester, Rochester, New York, for the continuation and completion of his studies on the Post-Glacial continental uplift in New England and the Maritime provinces of Canada.

$250, to Professor S. D. Townley, secretary, Seismological Society of America, Stanford University, California, for the investigation of earthquake phenomena.

E. C. PICKERING,
Chairman of Committee on Grants

THE NATIONAL ACADEMY OF SCIENCES

THE National Academy of Sciences held its annual meeting April 22–24, 1918, at the

Smithsonian Institution, President Walcott presiding.

The scientific program which was printed in the last issue of SCIENCE included reports of important researches, summaries of war work connected with the National Research Council (a committee of the Academy), and the William Ellery Hale lectures on "The Beginning of Human History from the Geologic Record," by Dr. John C. Merriam, of the University of California.

At the annual dinner, held Tuesday evening at the Cosmos Club, the following medals and awards were presented:

The Comstock Prize of $1,500 for discoveries in magnetism and electricity was awarded to Samuel Jackson Barnett, Ohio State University, Columbus, Ohio.

The Draper Medal for discoveries in astronomical physics, to Walter Sydney Adams, Mount Wilson Solar Observatory, Pasadena, California.

The Daniel Giraud Elliot Medal and Honorarium, for work in paleontology and zoology, to Frank M. Chapman, American Museum, New York.

Members of the Council elected were W. H. Howell and C. G. Abbott.

The new members elected were:

Robert Grant Aitken, astronomer, Lick Observatory, California.

George Francis Atkinson, botanist, Cornell University, Ithaca, New York.

George David Birkhoff, mathematician, Harvard University, Cambridge, Mass.

Percy Williams Bridgman, physicist, Harvard University, Cambridge, Mass.

Stephen Alfred Forbes, zoologist, Urbana, Illinois.

Charles Elwood Mendenhall, physicist, University of Wisconsin, Madison, Wisconsin.

John Campbell Merriam, paleontologist, University of California, Berkeley, California.

Henry Norris Russell, astronomer, Princeton University, Princeton, New Jersey.

David Watson Taylor, engineer, Rear Admiral, and Chief of the Bureau of Construction and Repair, Department of the Navy, Washington, D. C.

John Ripley Freeman, engineer, Providence, Rhode Island.

Charles Judson Herrick, neurologist, University of Chicago, Chicago, Illinois.

Ludwig Hektoen, pathologist, University of Chicago, Chicago, Illinois.

Frank Baldwin Jewett, engineer, Western Electric Company, New York City.

Walter Jones, physiologist, Johns Hopkins University, Baltimore, Maryland.

Irving Langmuir, chemist, General Electric Company, Schenectady, New York.

SCIENTIFIC NOTES AND NEWS

The Geological Society of France has awarded to Dr. Henry Fairfield Osborn the Gaudry Medal, which was established by the society in the year 1910 in honor of the distinguished French paleontologist, Albert Gaudry. Previous awards of the medal have been to the following paleontologists and geologists: Albert Gaudry, 1910; Marcellin Boule, 1911; Henri Douville, 1912; Eduard Suess, 1913; Emile Haug, 1914; Charles D. Walcott, 1917.

Dr. Louis A. Bauer, director of the department of terrestrial magnetism, Carnegie Institution of Washington, has been elected a foreign correspondent member of the Royal Academy of Sciences of Netherlands India.

At the last session of the Paris Academy of Medicine, an election was held to fill the places of Dr. Duguet and Professor Reclus in the section of internal pathology and external pathology, respectively. To the former Dr. Pierre Teissier was elected by 55 out of 62 votes, and to the latter, Dr. Felix de Lapersonne was elected by 49 out of 61 votes.

The recalling of Dr. Allan J. McLaughlin to the United States Public Health Service to become assistant surgeon-general in charge of the Division of Interstate Quarantine, left a vacancy in the health commissionership of Massachusetts, which has been filled by the appointment of Dr. Eugene R. Kelley, who went into office on April 1. Dr. Kelley was formerly commissioner of health of Washington, and for three years past has been director of the department of communicable diseases in the Massachusetts organization.

Mr. R. M. Stewart, who has been associated with the Dominion Astronomical Observatory at Ottawa since 1902, has been appointed assistant chief astronomer.

ATTENTION is called in the *American Museum Journal* to the fact that Dr. Frank M. Chapman, curator of ornithology, who is second in point of seniority on the scientific staff of the American Museum of Natural History, completed on March 1, 1918, his thirtieth year of connection with the institution. He joined as assistant curator of vertebrate zoology in 1888. "He has, from the first, devoted himself chiefly to ornithology, attaining preeminence in educational and scientific work in that branch. The effectiveness and high ecological value of the large series of habitat bird groups in the museum, which it is said by competent observers are second to no exhibits of birds in the world, are based on the careful observations made during his extensive field studies."

LIEUTENANT PETER K. OLITSKY, Medical Corps, U. S. A., and of the scientific staff of The Rockefeller Institute for Medical Research, upon permission granted him by the surgeon-general, sailed from Vancouver on April 11, for China, in response to a cabled request received by the institute from the colonial secretary at Hong Kong for assistance in a local outbreak of epidemic meningitis. Dr. Olitsky is to advise the Hong Kong government concerning the control of the disease, and especially in the preparation of an effective serum and the institution of other therapeutic and prophylactic measures.

AT the request of the South African Institute for Medical Research, The Rockefeller Institute for Medical Research has arranged with the Vermont State Department of Health to release Dr. Edward Taylor for temporary service in Johannesburg to advise the government there in respect to an epidemic of poliomyelitis prevailing in that region. Dr. Taylor sailed from New York on April 20.

DR. HERBERT J. SPINDEN, assistant curator in the department of anthropology at the American Museum, is on his way to Colombia, South America, to make a general archeological survey.

BRINGING an appeal for a doctor by Vilhjalmur Stefanson, the Arctic explorer, who lies dangerously ill on Herschel Island, a messenger reached Fort Yukon, Alaska, on April 25, after a record-breaking trip from the north. In a message carried by the courier Stefansson told of being ill fifty days, after being stricken with typhoid and pneumonia, followed by complications. A Northwest mounted policeman and two Eskimos have died of typhoid, while several others are ill. A doctor already is on his way to Herschel Island.

DR. H. C. COWLES, of the department of botany of the University of Chicago, visited the Iowa State College on April 12 and gave the annual address for the national honorary societies Phi Kappa Phi and Gamma Sigma Delta.

PROFESSOR S. W. PARR, professor of chemical engineering at the University of Illinois, recently gave an address at the Iowa State College before the Ames Section of the American Chemical Society.

THE annual oration of the Medical Society of London will be delivered by Dr. T. S. Hyslop on May 13, upon the subject of "Degeneration in Art, Science and Medicine."

A KNOLL on the University of Wisconsin campus on which John Muir, the naturalist and explorer, received his first lesson in botany under a locust tree while a student at the university, is to be officially dedicated and named "Muir Knoll." The ceremony will be held on alumni day, June 18, during commencement week.

THE deaths are announced of R. S. Trevor, lecturer on pathology and dean of St. George's Medical School, London, aged forty-six years and of G. A. Petrone, lecturer in pathology and pediatrics at the University of Naples, aged forty-four years.

CHARLES KEENE DODGE, of Port Huron, Michigan, died at Ann Arbor on March 22, in his seventy-fourth year. A correspondent writes: "For forty years he had been interested in the botany of eastern Michigan and adjacent portions of Canada, and for the last decade was unquestionably the foremost student of higher plants in these regions. He published many regional lists of plants. His

death will be deplored by all systematic botanists, as well as by all who knew his genial personality."

Dr. Ferdinand Braun, of Germany, who shared the Nobel Prize in 1905 with Guglielmo Marconi, for distinguished achievements in the invention of improved methods of wireless telegraphy, died on April 14 at a Brooklyn hospital. Death was caused by a heart attack induced by an overdose of morphine, which Dr. Braun is alleged to have taken before arriving at the hospital, to ease pain from an intestinal disorder from which he had been suffering for three years. Dr. Braun was born in Fulda, Germany, in 1850. He came to this country in 1914 as a witness in litigation between the Marconi Wireless Company and the German company which built and operated the wireless station at Sayville, L. I.

Mr. H. J. Helm, formerly deputy-principal chemist of the British Government Laboratory, has died at the age of seventy-nine years.

UNIVERSITY AND EDUCATIONAL NEWS

Mr. J. C. Lincoln has presented to Oberlin College the Mary McKenzie Lincoln Scholarship Fund, to be used in paying the term bill of some young woman, a student in Oberlin, who desires to continue her studies at the summer school of the Marine Biological Laboratory at Woods Hole.

Through the will of the late Henry Janeway Hardenbergh, of New York, Rutgers College has received Mr. Hardenbergh's library in architecture and the sum of $20,000. Mr. Hardenbergh designed and erected Geological Hall and the Kirkpatrick Chapel, and two years ago carried out the remodelling of the chapel.

Announcement has been made that President Wilson has directed the War Department to establish an infantry unit, senior division, of the Reserve Officers' Training Corps at Columbia University.

At the University of Buffalo medical school, Dr. Edward W. Koch has been appointed professor of pharmacology and Dr. Wayne J. Atwell, professor of anatomy, both on a full-time teaching and research basis.

Miss Phyllis M. Borthwick, lecturer in physics at the Ladies' College, Cheltenham, has been appointed assistant-professor of physics and chemistry at the Lady Hardinge Medical College for Women, Delhi.

DISCUSSION AND CORRESPONDENCE

NOTE ON A REVERSE CONCENTRATION CELL

In the Nernst theory of the concentration cell the solution tension of both electrodes is assumed to be the same, but the electrode in the more concentrated part of the electrolyte is supposed to have its rate of solution retarded by the back "osmotic pressure" of its own ions.

Another possible way of regarding the phenomenon is to suppose that the electrode in the solution of higher specific inductive capacity always goes into solution faster than the other, and hence becomes the anode. From this point of view, the solution of metallic salts in water lowers the specific inductive capacity of the water, and hence the electrode in the more concentrated solution of the concentration cell becomes the cathode.

A concentration cell for demonstration purposes is often made by pouring water carefully upon a concentrated solution of stannous chloride, so that the two liquids do not mix, and placing a rod of tin in the two solutions. The tin will rapidly dissolve in the dilute solution at the top, and crystals of tin will be deposited from the concentrated solution at the bottom.

If, instead of pouring water upon the concentrated solution, a solution of stannous chloride in ether be poured upon it and the two solutions be shaken together, most of the salt in solution will go into the water and only a little will remain in the ether and water at the top. Thus the tin ions are highly concentrated in the water and are very dilute in the ether, and their "osmotic pressure" is correspondingly greater in the water than in the ether. Notwithstanding this difference of concentration, if the tin rod be placed in the two solutions, ions will dissolve off it in the

concentrated solution of its own ions at the bottom, and small crystals of tin will form upon it in the dilute solution at the top.

The specific inductive capacity of the water solution must be much higher than that of the ether solution, even after being decreased by the ions in solution, since that of pure water at room temperature is more than 75 while that of ether is less than 4.5.

The results are quite as striking when lead acetate is dissolved in the water and ether and a lead wire is used for the electrode as the tin with stannous chloride. No doubt any salt that is slightly soluble in ether may be used just as successfully as those named above.

FERNANDO SANFORD
STANFORD UNIVERSITY

HERING'S CONTRIBUTIONS TO PHYSIOLOGICAL OPTICS

TO THE EDITOR OF SCIENCE: In your issue of April 19, page 388, you announce the death of Professor Dr. Ewald Hering and refer to him as "the eminent physiologist." Permit me to add that his chief work, for which he became well known, was in physiological optics and more especially the perception of color by the eye; his work in this direction is well-known and has been frequently referred to in literature in which it was coupled with that of the famous Helmholz, with whom he was for a time a contemporary.

Early in 1911 he was knighted, at the same time that Professor Roentgen was, by having conferred upon him the decoration of the Order "Pour le Mérite" for his creditable work and scientific researches. A description of his collection of experiments demonstrating phenomena in physiological optics, some of which the writer has had the pleasure of seeing in his own laboratories in Liepzig and Prague, would make very interesting and instructive reading and ought to be published.

In one of these a band of light was thrown on a screen, which every one without hesitation would acknowledge was a bright green when, as a matter of fact, there was absolutely no green present; the sensation of green light was a purely physiological effect due to a neighboring band of its complementary color. This peculiar phenomenon has suggested to the writer that there might perhaps be some way of utilizing it to advantage in supplying an additional color to colored moving pictures.

CARL HERING
PHILADELPHIA,

REFORM OF THE WORLD'S CALENDAR

TO THE EDITOR OF SCIENCE: In SCIENCE of April 19 appears a paper advocating "A Common Sense Calendar," by Professor Howard C. Warren of Princeton University. The changes proposed by Professor Warren would certainly prove a great improvement over the present highly archaic calendar that the world is burdened with as a heritage from our remote ancestors. But Professor Warren's scheme could be farther simplified.

The subject of a reform in the calendar was agitated quite widely some half dozen years ago; and about five years ago an international commission charged with the consideration of this subject was located in Berne, Switzerland. This commission sent out invitations to all who cared to do so, to submit suggestions upon the question of reforming the calendar, and this writer had the temerity to offer a scheme for a new calendar.

This scheme embodies one very radical change, which if accepted would reduce the problem to the last degree of simplicity, to wit, the division of the year into thirteen lunar months of four complete weeks, or twenty-eight days each. It was proposed to intercalate a thirteenth month (with the suggested name of Sol) between July and August of the existing calendar.

The extra day in each year should be disposed, as suggested by Professor Warren, that is, inserted between the last day of the old and the first day of the new year. The year might be made to begin on a day more in accord with nature's harmonies, that is, in the beginning of spring instead of the middle of winter; but that is not a vital matter. The extra day to be dealt with every fourth year, to be called "Leap Day," might be conveniently inserted bewteen two of the summer months.

It can readily be seen that this scheme would synchronize the days of the week, the month, and the year, throughout.

The international commission above referred to seems to have faded out with the advent of the war.

T. G. Dabney

Clarksdale, Miss.,

SCIENTIFIC BOOKS

A Check List of North American Amphibians and Reptiles. By Leonhard Stejneger and Thomas Barbour. Cambridge, Massachusetts, Harvard University Press. 1917. 125 pages.

The check list of North American reptiles and amphibians which has recently been published will undoubtedly initiate a new period in the herpetology of the continent, for it appears opportunely and has been carefully prepared by the two foremost students of the subject.

There has long existed an urgent need for such a work. The last check list (Garman, 1884) was superseded by Cope's monographs on "The Batrachia of North America" (1889) and "The Crocodilians, Lizards and Snakes of North America" (1900) which have remained the most recent attempts toward complete lists. Cope's books contain many inaccuracies, and since their appearance the field work of a number of museums and the studies of several investigators have materially increased our knowledge of the subject. The results of recent studies have appeared in excellent monographs, such as Dickerson's "The Frog Book," Van Denburgh's "The Reptiles of the Pacific Coast and Great Basin," and Stejneger's "The Poisonous Snakes of North America," and in numerous, small, widely scattered papers, many of which are only to be found in the large libraries. The result of the unorganized condition of the subject was that only the herpetologist knew what forms were to be recognized, and, owing to the chaotic condition of the nomenclature, only the specialists who had access to the large and older collections were in position to decide upon the names that should be used.

The check list evidently is not a mere list of described forms, but represents an attempt at a rather thorough reorganization of the systematic herpetology of the area which it covers. As stated in the introduction, it "has been prepared generally upon the lines of the American Ornithologists Union Check List of Birds, and, following that example, it has included the species and subspecies which the authors deem valid and of certain occurrence in North America, north of the Rio Grande, and in Lower California, Mexico." Certainly a painstaking attempt has been made to rectify the nomenclature, and just as certainly no two investigators were better qualified for the task than Dr. Stejneger and Dr. Barbour. Their ability, experience and knowledge of the subject, evidenced in their contributions to the field of systematic herpetology, and the fact that they are curators of the two largest and oldest collections of amphibians and reptiles in America are generally known, and their names on the title page will at the same time give herpetologists confidence in the work and give the book an authority that it would not have otherwise. This is very fortunate not only because the check list was needed, but also because it was time that an authoritative work appeared which could by emendations be perpetuated as has been the check list of the American Ornithologists Union.

The arrangement of the subject-matter is excellent. It may be described as follows: The genera and higher groups are in systematic sequence; the species are in alphabetic order and only those believed to be valid are included; the names are followed by citations of their original appearance except in the case of family names, which are formed automatically; the reference to the original description is followed in the case of genera by the type species, in the case of species by a reference to the first appearance of the name in the combination adopted; under each species a reference is then given to Cope's "North American Batrachia" or "The Crocodilians, Lizards and Snakes of North America"; and finally the type locality and the range of each species or subspecies is given.

One of the features of the work that will command attention is the nomenclatural changes. Such old friends as *Diemyctilus, Ambystoma punctatum, Spelerpes, Bufo lentiginosus, Eumeces* and *Elaps,* are supplanted respectively by *Notophthalmus, Ambystoma maculatum, Eurycea, Bufo terrestris, Plestiodon* and *Micrurus.* That much abused name *Coluber,* which has probably been attributed to more groups of snakes than any other and was finally (1907) given by Stejneger to the old-world vipers of the genus usually known as *Vipera,* is now given to the racers (*Zamenis*). Perhaps the most curious changes are in the names of the northeastern hognosed snake, hitherto *Heterodon platyrhinus,* and the copperhead, generally known as *Agkistrodon contortrix.* The former becomes *Heterodon contortrix,* the latter *Agkistrodon mokasin.* It is unfortunate that it has been found necessary to make so many changes in the names, but it can not be denied that the nomenclature in these groups was in need of revision and that the only way to secure stability in nomenclature is to adhere to the rules which have been adopted for determining the names which shall be used.

The stand which the authors have taken on the question of trinomials is commendable. "As for the admission of subspecies—or rather trinomial designation—for certain forms no special attempt has been made at consistency, the authors on principle leaning towards binomials in all cases where the need of trinomials has not been clearly established." This is precisely the method which if followed will permit advancement in our knowledge of relationships in these groups. To conceal the fact that a form is a true species by the use of a binomial designation is quite as bad practise as to use trinomials loosely and thus destroy their significance.

There is abundant evidence that the writers have made a critical study of the status of the species which have been described. There will be differences in opinion here, and more particularly as our knowledge increases, but the rejection of a considerable number of forms which are not valid and which have been a source of confusion will be of distinct advantage to the student. With good judgment the authors have been conservative in this matter. They could not be expected to examine the status of all of the more recently described forms nor to make detailed studies of the genera which are notoriously difficult, and they have adopted the rule of accepting "the judgment of reliable workers . . . where no special reason appeared to contraindicate the validity of the form."

The geographic data will appeal to the student who has had to search through an extensive literature to determine the range of a form, and who has frequently encountered difficulties in determining type localities. Too often the type localities have been omitted or only generally stated in the original descriptions, and it is fortunate that in this book "The type localities are as exact as it is possible to determine." The authors admit that this can not be said of the ranges. "Many are obviously faulty, but a sincere attempt has been made to collect records of authentic captures; however, with a literature so extensive and so scattered, records have almost surely been overlooked. In many cases, our knowledge does not warrant drawing hard and fast lines delimiting a form's occurrence, and we often state ranges in purposely general terms." A perusal of the work will show that the ranges are fairly well defined. There are, however, a number of inaccuracies in the summaries, and the subject has received unequal treatment. Thus *Rana sylvatica* does not extend westward to the Great Plains, *Rana cantabrigensis* extends eastward to Wisconsin and Michigan, *Eumeces skiltonianus* is not confined to California but ranges eastward through Nevada to Utah, and the ranges as given for *Pituophis sayi* and *Natrix sipedon* are too general to be of much use. One may grant the difficulties in gathering all of the records and in drawing definite boundaries, and recognize that too much detail would make the check list cumbersome, but it is suggested that the value of the book would have been greater if the ranges of the amphibians, lizards and snakes had been as uniformly well defined

as have been the ranges of the turtles. A knowledge of the distribution is of assistance to the herpetologist for the clues to relationships which it gives, it aids the student who is not an expert herpetologist to identify his specimens, and it encourages geographical studies and the publication of local lists. In view of its importance in systematic work the subject may well receive careful attention in lists of this kind.

It should not be concluded that the value of the check list is seriously impaired by the shortcoming just mentioned. The criticism is meant to be constructive, for it must be the hope of all herpetologists that this very useful book will be the first edition of a permanent check list. That it may be, the reviewer suggests that it be officially adopted by the American Society of Ichthyologists and Herpetologists, and that the authors be appointed permanent editors.

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SPECIAL ARTICLES

IDENTITY OF ATOMIC WEIGHT AMONG DIFFERENT ELEMENTS

Auguste Piccard has recently suggested[1] that the "element" uranium may be composed of three isotopes, there being in addition to uranium I. and its descendant uranium II. a long-lived element of atomic weight "about 240" which is the parent of the actinium series of elements, but has no genetic connection with the uranium series. This "actino-uranium" is supposed to undergo an alpha ray change to form uranium *Y*, which through uranium *Z* gives rise to the actinium elements. The hypothesis is attractive for three reasons. It establishes the actinium series as a wholly independent series, as the Geiger-Nuttall relationships between the half-life periods and the alpha ray ranges seem to demand. It gives a plausible origin for the puzzling uranium *Y*. Finally, it accounts for the fact that the atomic weight of uranium, instead of being, as would be expected, just twelve units higher than that of radium, *i. e.*, 238.0, is 238.167 according to Hönigschmid's authoritative work; for Piccard assumes that the atomic weight of uranium I. itself, the chief constituent of the uranium pleiad, is 238.0 and that the admixture of the heavier actino-uranium is responsible for the higher value from the analytical determination.

This hypothesis is so attractive that Wolfke[2] has already issued a copy of the periodic table of the elements in which the actinium elements are given atomic weights which follow from the assumption that the weight of actino-uranium is 240.0. It should be pointed out, however, that this assumption tacitly involves the statement that two elements may occupy the same position in the periodic table, as is commonly accepted for the isotopes, and may in addition have identical atomic weights and yet be different elements. This is a new type of isotopism. In the lead pleiad there are seven elements with atomic weights ranging from 206 to 214, all with identical chemical properties though differing in stability and in their radiations. According to Wolfke's table not only is the range of atomic weights in this pleiad extended to 216 (for actinium B) so that it covers fully ten units of atomic weight, but there are two elements, actinium D and thorium B, both of which have an atomic weight of 212 and which are therefore identical in atomic number and atomic weight, and yet the former is apparently stable while the latter has a half-life period of 10.6 hours and emits beta rays. Actinium C^1 and thorium A form another such a pair of elements, actinium X and mesothorium 1 still another, while the identity between radio-actinium and thorium itself is perhaps even more striking. With the same atomic number and atomic weight, they are chemically inseparable, they both give alpha rays, yet their periods are 18.9 days and 1.5×10^{10} years, respectively, and their descendants are quite distinctive.

According to this hypothesis, then, the atomic weight is almost wholly devoid of in-

[1] *Archives des Sciences Physiques et Naturelles*, 44, 161–64, 1917.

[2] "Ueber den inneren Bau der Atome," Zurich, 1917.

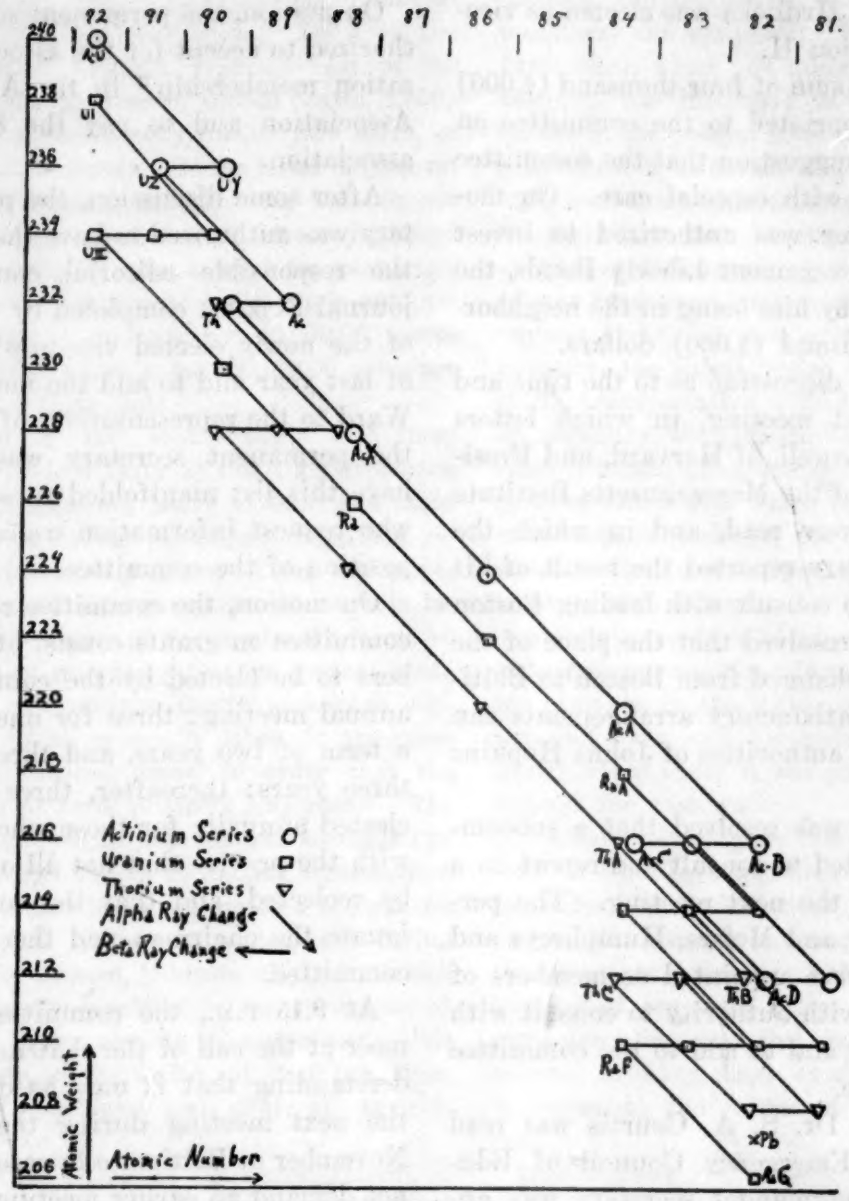

FIG. 1.

fluence on the internal properties of the atom and is solely a mass effect. All the intra-atomic characteristics, both chemical and physical, are dependent on details of atomic structure, on subatomic structural isomerism, which requires much further elucidation. There is nothing improbable about this view. Yet Piccard's suggestion by no means requires it. Until this further consequence of the theory of isotopes is experimentally verified Piccard's hypothetical actino-uranium will serve just as well if we assume its atomic weight to be 239 or 241 and thus avoid this theoretical elaboration.

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

MINUTES OF THE COMMITTEE ON POLICY

The committee met at the Cosmos Club, Washington, at 5.35 P.M., Monday, April 22, 1918, with Mr. Nichols in the chair and Messrs. Noyes, Woodward, Humphreys, Cattell, Ward and Howard also present. The minutes of the meeting of December 30, 1917, were read and approved. The permanent secretary reported concerning the present condition of the membership and a brief discussion followed on general conditions.

The election of Mr. John Barrett as a fellow and as vice-president of Section I was con-

firmed. Dr. Aleš Hrdlička was elected as vice-president of Section H.

On motion, the sum of four thousand (4,000) dollars was appropriated to the committee on grants, with the suggestion that the committee use this amount with especial care. On motion, the treasurer was authorized to invest spare funds in government Liberty Bonds, the amount reported by him being in the neighborhood of one thousand (1,000) dollars.

After extended discussion as to the time and place of the next meeting, in which letters from President Lowell, of Harvard, and President Maclaurin, of the Massachusetts Institute of Technology, were read, and in which the permanent secretary reported the result of his visit to Boston to consult with leading Boston members, it was resolved that the place of the next meeting be changed from Boston to Baltimore, provided satisfactory arrangements can be made with the authorities of Johns Hopkins University.

On motion, it was resolved that a subcommittee be appointed to consult and report on a general plan for the next meeting. The permanent secretary and Messrs. Humphreys and J. C. Merriam were appointed as members of this committee, with authority to consult with other individuals and to add to the committee if found desirable.

A letter from Dr. S. A. Courtis was read relative to the Emergency Council of Education and the permanent secretary was authorized to ask Dr. E. F. Buchner to represent the Association at the next meeting of that organization.

The requests of the Seismological Society of America and the Optical Society of America for admission to affiliation were acted upon favorably and it was resolved that non-members of these societies be admitted to the Association during this year without the payment of the entrance fee.

On motion, it was resolved that the New Orleans Academy of Sciences be admitted to affiliation with the association or, if the Academy prefers, the permanent secretary was authorized to arrange for its establishment as a local branch of the association.

On motion, the permanent secretary was authorized to accept for the association "organization membership" in the American Metric Association and to pay the $10 fee for the association.

After some discussion, the permanent secretary was authorized to have the composition of the responsible editorial committee of the journal SCIENCE completed by the substitution of the newly elected vice-presidents for those of last year and to add the name of Henry B. Ward to the representatives of Section K, and the permanent secretary was authorized to have this list manifolded to send to members who request information concerning the composition of the committee.

On motion, the committee resolved that the committee on grants consist of nine (9) members to be elected by the council at the next annual meeting: three for one year, three for a term of two years, and three for a term of three years; thereafter, three members to be elected annually for those whose terms expire, with the proviso that not all of the three shall be reelected, and that the council shall designate the chairman and the secretary of the committee.

At 9.15 P.M., the committee adjourned, to meet at the call of the chairman, with the understanding that it may be desirable to hold the next meeting during the third week of November at Baltimore in case emergency does not demand an earlier meeting.

L. O. HOWARD,
Secretary

SECTION M—AGRICULTURE

THIS Section held two sessions at the Pittsburgh meeting, in Thaw Hall, University of Pittsburgh, one on the afternoon of December 28 and the other on the morning of December 29, 1917. At the latter session the address of the retiring Vice-president of the Section, Dr. W. H. Jordan, was presented, the subject being "The Future of Agricultural Education and Research in the United States."[1]

The feature of the session on the afternoon of December 28 was a symposium on "Factors Concerned in an Increased Agricultural Production."

[1] SCIENCE, N. S., Vol. XLVII., p. 125.

Considering the subject from the standpoint of "The present status of production," Dr. John Lee Coulter, of West Virginia, reported that of the total land area of continental United States, 1,900,000,000 acres, approximately 900,000,000 acres, or less than half, is in farms. Of the latter only about half is improved land, much of the balance not even being used for pasturage. Of the improved land, about 90,000,000 acres is used for pasturage, some 20,000,000 acres around buildings is not productively employed, and another 40,000,000 acres annually lie fallow; *i. e.*, some 150,00,000 acres are not employed to their limit.

Improvement, he felt, should begin with these areas, and he did not favor at this time expansion into new areas requiring heavy expense and labor for development through drainage, irrigation, removal of stumps and stones, etc. There was ample opportunity for all the necessary and possible increase within the limits of farms already in active operation. In an emergency like the present, state and national governments should encourage concentration of effort, especially labor, in the more productive agricultural areas, in order that the largest amount of farm products may result. The drainage of improved farm lands was advocated as one of the effective means of making efforts more productive, and also liming to sweeten the soil on millions of farms. It was advocated that during the war the government "devote all funds which can be intelligently expended in the promotion of agriculture on farms already in active use. This will include help in the matter of drainage, lime, fertilizers, seed, machinery and, above all, agricultural labor."

Referring to the effects of the tenant system, it was argued that more studious care on the part of the land owners through supervision could do more toward increasing production than most any other means.

The "Obstacles to enlarged production" were set forth succinctly by Professor W. D. Hurd, of Massachusetts. These cover a wide range and their enumeration showed the great extent to which the producers of the country are required to cope with difficulties, some of which inhere in the status of the industry and many of which are outside of human control.

Conspicuous among the obstacles to enlarged production are the systems of management which farmers are following, unwise and inefficient marketing, the enormous losses from plant diseases and insects and other pests such as rodents in the fields and storage buildings, the ravages of animal diseases, and the lack of adequate supply of farm machinery and equipment. The inadequacy of good farm labor, which has become very acute in many sections, was instanced as one of the chief obstacles at the present time. The possible means of relieving this situation and the efforts which the state and federal governments and other agencies are making in that direction, were detailed.

Other obstacles were noted which have arisen out of war conditions, such as the shortage of seed of various kinds, the lack of fertilizers in sufficient quantity, the shortage and high price of feeding stuffs, transportation difficulties, etc. Again, lack of necessary working capital and the absence of efficient organization among farmers to meet the organized forces with which they have to contend in their outside dealings, are elements of weakness which tend to restrict production and to make an increase more difficult.

Among uncontrollable factors are those of climate and season, the effects of which were cited, for example, in the large percentage of soft corn the past year, and the reduction in the area of winter wheat which it was possible to sow or bring through the past wnter.

Professor Hurd gave many interesting illustrations of what is being done to overcome many of the difficulties under which farmers are laboring and to aid them in meeting such as can not be eliminated or reduced. This made a remarkable showing of organized effort for relief and assistance, extending over the whole range of tbe agricultural industry, from which much was predicted in increasing the output of the nation's agriculture.

In discussing "The limiting factors in production" Director Charles E. Thorne, of Ohio, pointed out that increased production must be accomplished either through increase of area or by increased yield per acre. Increase in area involves a corresponding increase of capital and labor and is limited by the land which may be profitably added. The latter limit, it was felt, has been nearly or quite reached. The chief limiting factors in crop production were stated as (1) inadequate drainage of lands in cultivation, against which two obstacles have been removed, by providing capital through the farm loan banks and machinery to simplify the labor problem; (2) deficiency of lime in many soils, the remedy for which is associated with problems of labor and transportation; (3) neglect of crop rotation, which both scientific research and actual farm practise have demonstrated to be necessary in growing cereals economically;

(4) phosphorus hunger, a fundamental factor, since "in no other way can the production of wheat be increased as quickly and as effectively as by placing an abundant supply of acid phosphate within the reach of the farmers [east of the Mississippi] at a reasonable price"; (5) insufficient transportation—to meet the needs of drainage, liming, fertilizing and other supplies, as well as the movement of products; and (6) labor deficiency, which limits improvement in all directions.

Despite the development of farm machinery and scientific methods of farming, human labor is indispensable, and "each improvement in machinery or in method has made it more and more necessary that that labor be something more than mere brawn." Even common labor unskilled in farm work, it was pointed out, is not to be had at wages which the prices of farm products justify. It was maintained that the increased production of food is dependent chiefly upon such coordination of wages and prices of farm produce that the cost of the increased production may not be greater than its market value, and upon such coordination of transportation activities that the farmer may obtain the tile, lime and fertilizers essential to an enlarged production. The thesis was laid down that "in the present emergency the production of food is not less important to the nation's life than the production of munitions or carrying the rifle," and further that, "if food production is to be maintained the prices of farm products must be such as to permit the payment of wages corresponding to those paid in the production of munitions." To meet the necessities of war, the speaker went so far as to advocate selective conscription of labor for the production, manufacture and transportation of food and munitions, contending that selective conscription for the necessary support of the military service is equally defensible with selective conscription for military service.

In considering the subject from the broad standpoint of "The human element," Mr. Herbert Quick, of the Federal Farm Loan Board, developed a strong, logical argument for education suited to the agricultural industry and its environment. Starting with the now recognized fact that the hands are controlled by the mind, and that the mind back of the operation is far more important than the body, he contended that this faculty must be trained and guided to make it effective and to develop in it a proper attitude toward its occupation and environment. Men are bound to their occupations by a variety of elements, and it is not alone the financial side which makes a calling attractive. Traditional respect binds people to an occupation, as in the case of the professions. Public appreciation of what one is doing is another factor in binding men to their work, and agreeable environment is often another important consideration. But the thing that most of all binds a man to his occupation is that it engrosses all of his powers, that it brings into action every power of his being.

Farmers have been largely deprived of these stimulating influences. They have been looked down upon historically, as is shown, for example, by the origin of many common words in our language. Their art has been based largely on tradtion and experience. Their environment has been hard and neglected. And schools have been prescribed for them and books employed which have educated children away from farming and caused them to look to other walks of life for careers which would engross their powers, bring appreciation and position, and return a large measure of satisfaction.

Conditions are now changing. Already the attempt at agricultural teaching has shown its advantage in making the farming occupations more attractive, more gratifying, and a source of pride, and in producing more effective workers. Where the country school is right the children stay in it longer and feel a real pride in it. Where properly developed, it was predicted that it will turn the tide and retain the children in the country. Its position is a fundamental one and it will affect all rural industries and institutions. The permanent basis of increased agricultural production is the development of the farm people and especially the children; and most important of all, for permanent advancement "we need in this country a farm population engaged in a grapple with its own problems." The accomplishment of these ends was placed back on the country school.

The officers of the Section elected for 1918 were as follows: Vice-president, Dr. H. P. Armsby, director of the Institute of Animal Nutrition, State College, Pa.; Member of the General Committee of the Association, Dr. R. A. Pearson, Assistant Secretary of Agriculture; Member of the Council of the Association, Dr. C. E. Marshall, Massachusetts Agricultural College, Amherst, Mass.; Member of the Sectional Committee (for five years), Dr. John Lee Coulter, dean of the college of agriculture, West Virginia University.

E. W. Allen,
Secretary